PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Electric Fuses for Explosive Shells.

We, RHEINISCHE METALLWAAREN-UND MASCHINENFABRIK, a body corporate organised under the laws of Germany, of 172, Ulmenstrasse, Dusseldorf, Derendorf, Germany, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

In electric fuses, time or impact fuses, the primer for the bursting charge is ignited in known manner by a heating or fuse wire which is automatically inserted in the circuit of a source of current. The source of current in fuses may be accumulators, dry or wet batteries, or generators actuated by the rotational movements of the shell, the current produced controlling an electromagnetic switch gear, which after a definite set time closes the circuit of the source of current over the fuse wire and thereby ignites the primer.

The complicated and sensitive switch gears are not required in fuses according to the invention; according to which the ignition is effected, at an exactly predetermined time after the shot has been fired, by proportioning the strength of the current in the fuse wire to a definite value which raises the fuse wire, after a shorter or longer time, to the required temperature for igniting the primer.

The current is preferably adjusted to the strength necessary for effecting the ignition at the required time, for example by a regulating resistance inserted in series with the fuse wire, a method of regulation which can be employed with any suitable source of current, and by means of which it is possible to determine exactly the time of ignition. The regulation of the current strength can also be effected in another manner by a regulating device particularly adapted for the type of current source employed as described below.

[Price 1/-]

A permanent magnet is utilised as the source of current for the electric time fuses, and at the moment of firing the shell is displaced relatively to or in a coil and produces an induction current therein which serves for heating the fuse wire of the primer. This source of current previously used only for impact fuses has, as compared with the elements employed in known time fuses, such as accumulators or generators, the advantage of great simplicity and insensibility, while any number can be kept in stock.

Since the current is only produced and maintained by means of the permanent magnet for a small period of time, in order to be able to increase the time the current is not conveyed directly over the regulating resistance to the fuse wire, a condenser is first charged by the current and is then discharged over a resistance, set to a definite value, and the fuse wire.

By the use of a permanent magnet, which in known manner on the impact of the shell on the target is relatively displaced and thereby produces a current of electricity, in conjunction with the current regulating device according to the invention, a simple and reliable electric impact fuse with an adjustable time delay is obtained, and, by a suitable arrangement and construction of the interior electric apparatus can be used as an electrically operated combined time and impact fuse.

The drawing represents examples of embodiments of the invention as applied to a time fuse.

Fig. 1 shows the fuse in longitudinal section;

Fig. 2 is a cross-section on the line A—B of Fig. 1;

Fig. 3 is a diagrammatic view of a second embodiment, and

Fig. 4 is a detail modification of Fig. 3, also shown diagrammatically.

A permanent magnet *a* is mounted in the longitudinal axis of the shell so as to be displaceable longitudinally. It is secured by a transport safety device of known kind, for example by a locking spring *b*, in its front end position in the head of the shell. A bobbin *c* secured in the head of the shell and provided with several turns *d* of insulated copper wire surrounds the magnet. The two ends of the winding *d* are connected to a condenser *f* which, for example, may be formed as a paper wound condenser, with tin foil sheets insulated from one another by paper. One end of the winding *d* is connected over a contact *e* with one armature of the condenser *f*; the other end of the winding *d* is connected over a contact *g* to a conducting metallic strip *i* which is stretched at right angles to the path of the magnet *a* and is connected over a contact *k* to the other armature of the condenser *f*. The conductors *e*, *g*, *i* and *k* are insulated from the body of the shell.

The armature of the condenser *f* connected to the contact *e* is also connected with an insulated lead *l*. To this lead is connected at *m* one end of a fine resistance wire *o* embedded in the primer *n* and serving as the heating or fuse wire, which, as in glow lamps, can be wound spirally or helically or zigzag, or may be curved. The wire may be formed of silicon-carbide or other similar material. The other end of the resistance wire *o* is connected at *p* with a contact *q* which slides on the surface of a circularly arranged resistance *r*. The resistance *r* is insulated and fixed in a ring *s* which is rotatable and adjustable in the head of the shell. The ring in this case fulfils the function of the usual setting ring containing an inflammable composition. One end of the resistance *r*, which in the example represented is formed as a helically wound wire bent in annular form, is free, its other end is electrically conductively connected by a screw *t* to the ring *s* and thereby with the head of the shell.

On firing the shell, the magnet *a* is released by the inertia of its mass from the safety spring *b* and is displaced rearward in the head of the shell. By this movement, the lines of force of the magnet cut the windings of the coil *d* and produce in the latter an induction current by which the condenser *f* is charged, since, as previously mentioned, the coil *d* is connected with the two armatures of the condenser *f*. Shortly before reaching its end rear position, the magnet *a* impacts on the metal strip *i* and breaks it in the centre and one end of the strip is withdrawn from the contact member *g*. The circuit of the coil *d* over the condenser *f* is interrupted and the charged condenser *f* is cut off from the coil *d*.

At the same time, the circuit of the condenser *f* is closed over the fuse wire *o* of the primer *n* by the metal strip *i*, of which the central portion is pressed into contact with the rear nut of the head of the shell by the magnet. The current consequently passes from one armature of the condenser *f* over the conductor *l* and the screw *m* to the fuse wire *o* and flows from the latter over the screw *p* and the contact *q* to the resistance *r*. According to the angular setting of the ring *s* in the head of the shell, the current flows through a larger or smaller number of turns of wire, that is, through a greater or smaller length of the resistance wire, until it passes at its end *t* into the body of the shell and in its return path to the metal strip *i* and thence to the contact *k*, and the other armature of the condenser *f*. According to the amount of the resistance inserted in the winding of the resistance *r*, a larger or smaller current flows in the circuit and thereby also through the fuse wire *o* of the primer *n*.

In the fuse wire *o* heat is produced according to Joule's law of $Q = 0.24\ I^2$ r.t.g. calories. That is, the amount of heat produced is dependent on the strength of the current. Since a definite temperature is necessary for igniting the primer, with a current of lesser strength ignition only occurs after a longer period of time. On the other hand, with a current of greater strength, ignition occurs after a shorter interval. By means of the regulating resistance *r*, the current strength and also the time required for ignition can be adjusted. The ring *s* is, like the known composition rings, provided with a scale indicating the time of ignition after firing, which scale in combination with a mark on the head of the shell enables the time of ignition set at any time to be read off.

In the construction shown in Fig. 3, the magnet *a* is displaced on firing the shell, as in the previously described example, through the coil *d* and produces in the latter an induction current which charges up the condenser *f*. The path of the current is in this case from one end 1 of the coil *d* over the points 2, 3, 4, 5 to the other end 6 of the coil *d*. During the charging up of the condenser *f* part of the induction current is supplied to a second circuit 1, 2, 7, 8, 9, 10, 11, 12, 6, over the primer *n* and an exactly adjusted invariable resistance *w*.

This second circuit effects a preliminary heating of the fuse wire *o*. If, for

example, the ignition point of the primer is at 400° C., the fuse wire is previously warmed through this circuit up to about 350° C. At the end of the movement of the magnet *a* relative to the coil *d*, the latter is cut off from the condenser *f* and the circuit for preheating the fuse wire is opened. The metal strip *i* then takes the position shown in interrupted lines and connects the condenser *f* to the fuse wire *o* and the resistance *r* adjustable by the sliding contact *u*. The condenser *f* is then discharged from one armature 4 over the points 3, 13, 14, 15, 10, 11, 12, 6, to its other armature 5. The current delivered during the flight of the shell from the condenser *f* is so proportioned by the resistance *r* that the fuse wire is heated from 350° C. to a temperature of 400° C. corresponding to the ignition point of the primer and thereby effects this ignition according to the time set on the indicating device of the resistance *r*.

Fig. 4 represents a device which is adapted for using the above-mentioned electric fuse as an impact fuse. If the primer is not brought to ignition at the time set during the flight of the shell, on impact of the shell on a target, a spring mounted contact member *v* is thrown forward against a fixed contact *x* by the inertia of its mass and thereby short-circuits the resistance *r*. The condenser charge is then directly discharged over the primer; and the latter is thereby ignited. According to another, not shown, arrangement, the movement of the magnet *a* due to its inertia when the projectile impacts on the target, is made available for producing electric energy. By means of a contact device, which automatically connects the induction coil *d* with the fuse wire *o*, electric energy is again set up on the coil and is led over the fuse wire and ignites the primer.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. An electric time fuse or delay-impact fuse for explosive shells in which the primer for the bursting charge is ignited by heating a fuse wire inserted in the circuit of a source of current, characterised by the strength of the current flowing to the fuse wire (*o*) being adjustable as required by suitable means, in order to heat the fuse wire in a shorter or longer time according to the adjustment of the current strength to the temperature necessary for actuating the primer (*n*).

2. Fuses according to Claim 1, in which a regulating resistance (*r*) is inserted for varying the current strength in the circuit of the fuse wire (*o*).

3. In a time fuse according to Claim 1 or Claim 2, the employment of a generator consisting of an induction coil (*d*) and a permanent magnet (*a*) displaceable therein, in which generator the electric energy is produced by the relative movement produced between the coil and the magnet on firing or on impact of the shell on a target.

4. Fuses according to Claim 1 or 2, in which the primary electric energy produced, for example by the displacement of a permanent magnet (*a*) in its coil (*d*) charges a condenser (*f*) which discharges over a regulating resistance (*r*).

5. Fuses according to Claim 4, in which, at the end of the movement of the magnet (*a*) relatively to the coil (*d*), the latter is automatically cut off from the condenser (*f*) and the circuit for discharging the condenser is closed over the regulating resistance (*r*) and the fuse wire (*o*).

6. Fuses according to any of Claims 1—4, in which, during the movement of the magnet (*a*) relatively to the coil (*d*) and the charging up of the condenser (*f*) consequent thereon, the fuse wire (*o*) is preheated by a current directly led through it from the induction coil (*d*).

7. Fuses according to Claims 4—6, in which a contact device (*r*—*x*, Fig. 4) closed by the impact of the shell on a target before or on the failure of the time ignition, automatically short circuits the regulating resistance (*r*) in the circuit from the condenser (*f*) to the fuse wire (*o*), so that the electric energy stored in the condenser is discharged without resistance over the fuse wire (*o*) and ignites the primer (*n*).

8. Time fuses according to Claim 1 or 7, in which, on the impact of the shell on a target before or on the failure of the time ignition, electric energy is produced by the displacement of the magnet (*a*) in the induction coil (*d*) and is led by an automatically operated contact device over the fuse wire (*o*) and effects the ignition.

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Fig.1.

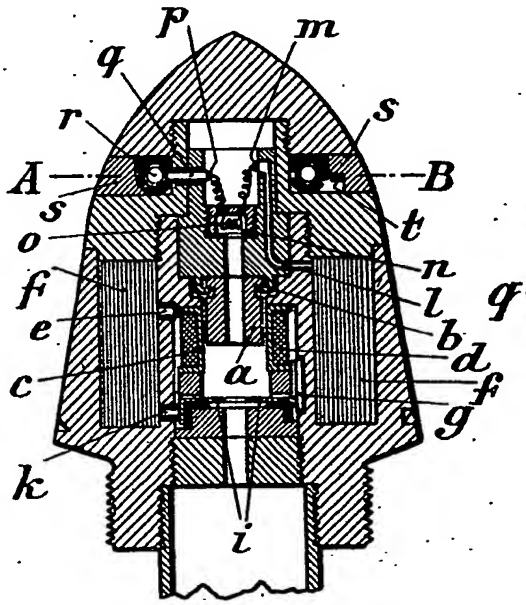


Fig.2.

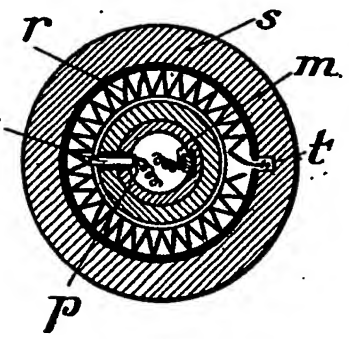


Fig.4.

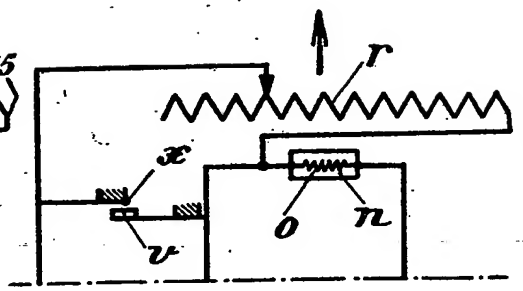
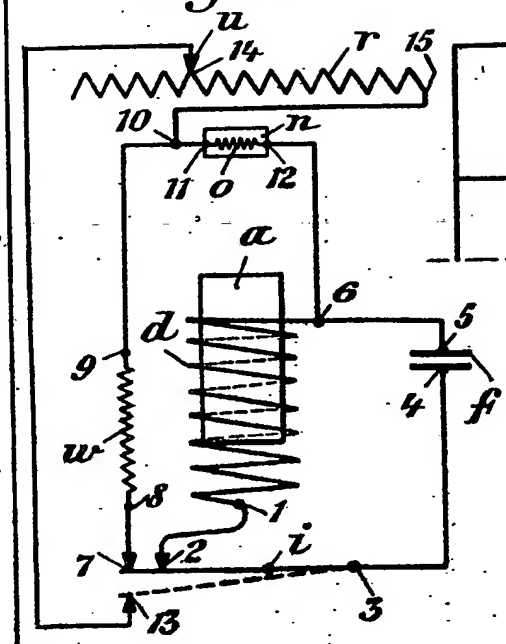


Fig.3.



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